

Relationship between Duration of Patellofemorall Pain Syndrome and Patellar Alignment

Zohre Ebrahimi ^a, Mohammad Akbari ^{a*}, Ali Amiri ^a

^a Department of Physical Therapy, Iran University of Medical Sciences, Tehran, Iran

*Corresponding Author: Mohammad Akbari, Department of Physical Therapy, School of Rehabilitation Sciences, P.O. Box: 1545913187, Tehran, Iran. Tel: +98-21 22227124; E-mail: Akbari.mo@iums.ac.ir

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Introduction: Patellofemoral Pain Syndrome (PFPS) is one of the most common musculoskeletal disorders. The cause of PFPS has been reported to be multifactorial. Patellar malalignments are accepted as the leading causes of PF pain and PF joint disorders. The purpose of the present study was to assess the relationship between duration of PFPS and patellar alignment. Method and Materials: The patellar alignment of participants was compared in three groups: patients with 2-3 month PFPS duration, patients with 12-15 months PFPS duration, and matched healthy participants. Congruence angle, Q angle, Patella height (Insall-Salvati index), Lateral patellar tilt angle, and Pain and Function score were measured among these three groups. Results: The patella height (Insall-Salvati index) ($r=0.32$), lateral patellar tilt angle ($r=0.28$), Visual Analogy Scale ($r=0.77$), and function score ($r=-0.80$) correlated with duration of PFPS. The patella height (Insall-Salvati index), lateral patellar tilt angle, and pain in patients group with 12-15 months of PFPS duration were significantly greater and function score was less than those of the control group. The patella height (Insall-Salvati index) and pain in patients group with 2-3 months of PFPS duration were significantly greater and function score was less than those of the control group. There was no significant difference in other measurements among the three groups. Conclusions: It can be concluded that duration of PFPS affects alignment of patella and knee joint function score. Therefore, early and complete treatment of PFPS is recommended.

Key words: Patellofemoral Pain Syndrome, Duration, Malalignment

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Introduction

Patellofemoral Pain Syndrome (PFPS) is one of the most common musculoskeletal disorders (1). Patellofemoral pain (PFP) is an anterior, retropatellar, and/or peripatellar pain that is aggravated by prolonged sitting and activities which load the patellofemoral joint, such as ascending and descending stairs, running, jumping, and kneeling (1-5).

PFP limits daily life activities and participation in sports (1, 6, 7) and is the most common reason why physically active people seek healthcare (8, 9). This condition accounts for 25%-40% of all sport injuries (4, 7, 8, 10, 11) and 37-43% of injuries in military trainings (3, 5). A total of 74% of patients will decrease their physical activity for at least 5 years because of PFP and about 70-90% of patients experience chronic or recurrent pain (5, 9).

Prospective studies demonstrated that PFPS is not self-treating, with probably persistent symptoms up to 20 years (6). It is also shown that having PFPS as a younger individual may

predispose one to develop patellofemoral osteoarthritis later in life (5, 6, 12-14).

The causes of PFPS are poorly understood (2, 4, 8). It can be caused by direct trauma to the knee and/or overuse (3, 15). A combination of factors, such as muscle weakness, decreased iliotibial band and hamstring flexibility, excessive subtalar pronation, and patellofemoral joint malalignment have been linked to PFPS (2, 15, 16).

Patellar malalignment is considered to be one of the primary precursors of PFPS (4, 13, 14, 17, 18). It can cause an aberrant dispersion of forces transmitted to patellofemoral joint and put uneven stresses on both patellar and peripatellar tissues, leading to PFPS (19-21).

Although many studies assessed patellar alignment in patients with PFPS, there are discrepancies in findings of these studies (3, 14, 20, 22-27).

Some studies have investigated the relationship between patellar alignment and PF osteoarthritis progression, morphology of Vastus Medialis Oblique (VMO), morphologic features of



Figure 1. Radiographic view. A) Lateral view; B) Axial view



Figure 2. Q angle measurement

femoral trochlea, mal-tracking, and pain and function score (19, 28-31). However, no study was found examining the relationship between patellar alignment and duration of PFPS. According to results of a prospective study, five years after completion of a rehabilitation program for PFPS, about 80% of the individuals still reported pain and 74% had reduced the level of their physical activity (5). The outcome and duration of chronic and non-chronic PFPS treatment is different, thus they may be prescribed with different treatment procedures.

As a result, the purpose of the present study was to assess the relationship between duration of PFPS and patellar alignment as identified by radiographic images. It was hypothesized that as duration of PFPS increases, patellar malalignment will increase.

Methods and Materials

Study design

The current cross-sectional study aimed at assessing the relationship between duration of PFPS and patellar alignment. Prior to the treatment, participants read and signed the informed consent form. The study was approved by the Research Ethics Committee at the School of Rehabilitation Sciences, Iran University of Medical Sciences.

Participant selection

A total of 25 participants (10 male and 15 female) reporting a history of PFP with a duration of 2-3 months (group 2), 25 participants (7 male, 18 female) reporting a history of PFP with a duration of 12-15 months (group 3), and 25 participants as the asymptomatic group (group 1) were invited to take part in the study.

Inclusion criteria were a. age between 18 and 40 years, b. PFP on at least 2 of the following activities: prolonged sitting, stairs climbing, squatting, running, kneeling, and jumping, and c. presence of pain during Clark Test and compression test (2, 32, 33). Exclusion criteria included a. history of trauma, patellar dislocation or subluxation, ligament, and menisci injuries, b. history of deformities of lower extremity, c. previous physical therapy or acupuncture for the knee (24, 28, 32, 33), and d. pregnant women with PFPS.

Procedure

An orthopaedic specialist referred patients with PFPS to the physiotherapy clinic. Data was collected by an examiner: a physiotherapist with clinical experience in orthopaedic rehabilitation. Demographic data, e.g age and duration of PFP, were collected and then weight and height were measured.

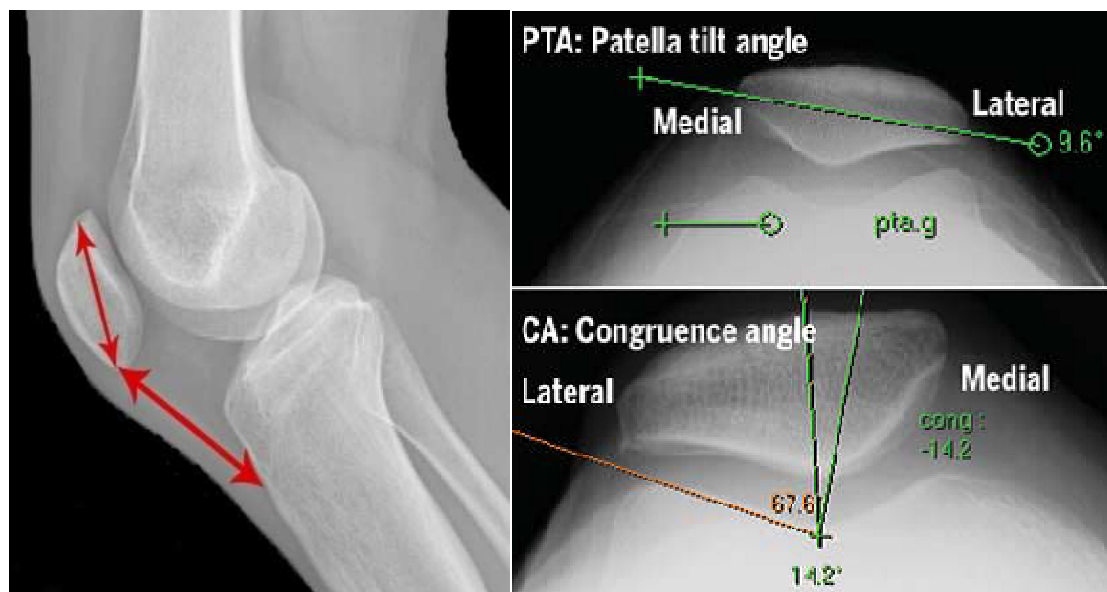


Figure 3. Patellar alignment measurements. **A)** Patella height (Insall- Salvati index) was obtained from lateral view (34); **B)** Lateral patellar tilt angle was obtained from skyline view (35); **C)** Congruence angle was obtained from skyline view (35)

Radiographic imaging procedure

Radiographic instrument was used to measure Congruence angle, Lateral patellar tilt angle, and patella height. All the participants were referred to a radiotherapy centre and two radiographs were obtained: 1. lateral view and 2. skyline view.

The lateral radiograph was taken first, with the participant positioned sideling on affected side with the knee flexed 35 degree, and measured using a standard goniometer. Radiographic plate was placed under the knee (26) (Figure 1A).

Skyline radiograph was taken with the participant seated with the hip positioned between 90°-110° flexion. The knee was supported between 90°-110° flexion via leg support. Radiographic plate was held by the participant (23, 26, 32, 36) (Figure 1B). A standard goniometer was used to measure Q-angle and others angles.

Alignment measurement

In the current study, Q-angle, Congruence angle, Lateral patellar tilt angle, patella height, and pain and function score were measured.

Q angle

The Q-angle was measured in standing position. The center of patella, tibial tubercle, and anterior superior iliac spine were located manually and marked with an ink pen. The participant was instructed to hold one end of a string on the ASIS. The other end of the string was taped to the midpoint of the patella. Goinometer was placed at the midpoint of patella. Fixed arm of goinometer was aligned with string linking to the ASIS and the movable arm was aligned with tibial tubercle and Q-angle was recorded (25, 37) (Figure 2).

Congruence angle, Lateral patellar tilt angle, patella height

Lateral patellar tilt angle and congruence angle were obtained from skyline radiographs. The congruence angle is formed by the bisected line of the femoral trochela (the sulcus angle) and the line projected from apex of the sulcus angle to the lowest point of the articular surface of the patella (26, 35) (Figure 3A). Lateral patellar tilt angle was defined as the angle formed between a line connecting the medial and lateral edges of the patella and a horizontal line (35) (Figure 3B). Also, Patella height was measured from lateral radiographs and quantified with the Insall-Salvati index. The Insall-Salvati index is calculated as the ratio of patellar tendon length (distance from anterior tibial tuberosity and the most inferior border of the patella) and the patella bone diagonal length (36, 38) (Figure 3C). Ratio <0.8 was defined patella baja and ratio >1.2 was defined patella alta (39).

Pain and function score

Pain severity was measured using a Visual Analogy Scale (VAS). VAS is a 10-cm horizontal line on which the two ends show minimal and maximal pain. In order to determine the severity of the pain, participants were asked to indicate their greatest level of knee pain during the past week by placing a dash at the appropriate level on the 10-cm horizontal line.

Functional score assessment of lower extremity was carried out using the Function scoreal Index Questionnaire adapted from Stratford. The scores ranged from a possible minimum of 0 to a maximum of 16 (40).

Table 1. Demographic variables of participation [Mean (SD)]

Variable	Group 1	Group 2	Group 3	P-value
Age (y)	27.56 (5.47)	29.28 (5.61)	29.84 (5.61)	0.77
Height (cm)	1.64 (10.08)	1.65 (0.74)	1.63 (0.09)	0.33
Weight (KG)	64.04 (7.26)	66.28 (6.84)	68.32 (10.40)	0.51

Table 2. Patellar alignment compared among the three groups [Mean (SD)]

Variable	Group 1	Group 2	Group 3	P-value
Q angle	18.08 (2.54)	18.28 (2.73)	19.08 (2.41)	0.38
Congruence angle	-11.36 (11.12)	11.76 (12.58)	-8.16 (15.71)	0.74
Lat patellar tilt angle	4.80 (5.40)	6.96 (6.14)	7.96 (4.51)	0.04
Patella height(cm)	1.02 (0.08)	1.07 (0.09)	1.11 (0.13)	0.02
Pain(VAS)	0 (0)	3.84 (1.59)	4.36 (1.46)	0.00
Function score	16 (0)	10.84 (2.77)	2.46 (9.08)	0.00

Table 3. Patellar alignment between groups 1 and 2, 1 and 3, and 2 and 3 (P-value)

Variable	Group 1 and 2	Group 1 and 3	Group2 and 3
Lat patellar tilt angle	0.11	0.01*	0.27
Patella height (cm)	0.05*	0.01*	0.09
Pain (VAS)	0.00*	0.00*	0.18
Function score	0.00*	0.00*	0.03*

*Significant difference among groups

Table 4. Spearman correlation coefficients

Variable	Correlation coefficients (r)	P-value
Q angle	0.15	0.18
Congruence angle	0.06	0.56
Lat patellar tilt angle*	0.28	0.01
Patella height*	0.32	0.00
Pain(VAS)	0.77	0.00
Function score*	-0.80	0.00

*Significant correlation among patellar alignment and PFPS duration

Statistical analysis

Data analysis was performed using SPSS (version 16). One way ANOVA was run to compare the age, height, and weight and Kruskal-Wallis test was used to compare the Q angle, congruence angle, lateral patellar tilt angle, patella height, function score, and pain among the three groups. Moreover, Mann-Whitney test was run to compare the lateral patellar tilt angle and patellar height among groups 1 and 2, 1 and 3, and 2 and 3. In addition, Spearman correlation coefficients were used to determine the extent of the relationship between patellar alignment, function score, and pain and PFPS duration. The significance level was set at $P < 0.05$.

Results

One way ANOVA & Kruskal-Wallis tests results

There was no statistically significant difference observed for age, weight, and height between the three groups (Table. 1). Q angle and congruence angle did not differ significantly between

the groups either. The mean of lateral patellar tilt angle in the group of 12-15 months PFPS duration (mean: 7.96) was statistically greater when compared with that of the control group (mean: 4.80) ($P=0.01$), but no significant difference was observed between the group of 2-3 months PFPS duration and control group regarding this variable ($P=0.11$).

Furthermore, patella heights in two groups with PFPS were statistically greater than that of control group (group 2: $P=0.05$, group 3: $P=0.01$).

Statistical analyses revealed significant difference in pain between the two groups with PFPS and control group (group 2: $P=0.00$, group 3: $P=0.00$). No significant difference was found in terms of pain between the two groups with PFPS ($P=0.18$).

The mean function scores were 10.14 in group 2 and 2.46 in group 3. Statistical analyses showed significant difference between the two groups with PFPS and among control group and the two PFPS groups regarding function score (group 2 and 1: $P=0.00$, group 3 and 1: $P=0.00$) (Tables 2 and 3).

Spearman correlation coefficients results

Lat patellar tilt angle ($r=0.28$, $p=0.01$) and patellar height ($r=0.32$, $p=0.00$) were positively correlated with PFPS duration. Pain was positively correlated ($r=0.77$, $p=0.00$) and function score was negatively correlated ($r=-0.80$, $p=0.00$) with PFPS duration. However, no association was observed between Q angle and congruence angle (Table 4).

Discussion

The purpose of the current study was to investigate the relationship between patellar alignments and/ pain and function score with PFPS duration. The results indicated that increase in PFPS duration was associated with the increase of lateral patellar tilt angle, patella height, and pain and functional impairments. Hanafy reported that pain appears in the patellofemoral joint as a result of patellar mal-alignment which finally leads to patellofemoral osteoarthritis. This condition is common in the patellofemoral joint with high contact pressure stresses imposed on the lateral aspect [41].

Comparison of the two groups with PFPS showed no significant difference in Q angle with control group. The findings of current study are in agreement with those reported by Caylor (25), but in disagreement with findings of the studies that have identified the Q angle as one of the predisposing factors for PFPS (24, 33). The previous studies did not consider duration of PFPS, a variable that can result in discrepancy in the mean angle measured. In addition, the reason for the disagreement between the studies mentioned could be the various methods of measurement. The reliability of the method used in the present study was calculated to be high and the method implemented was recommended by different authors. Hall and Horton reported the intrarater reliability of 0.92 and interrater reliability of 0.84 and Caylor reported intrarater reliability of 0.84-0.90 and interrater reliability of 0.83 (25). The present study indicated that Q angle in the group with 12-15 months duration of PFPS was greater than that in other groups, but the difference was not significant. Possibly, by increasing duration of PFPS to more than 15 months, significant difference and correlation between PFPS duration and Q angle would be observed.

No correlation was found between Q angle and duration of PFPS, either.

Furthermore, the congruence angle did not differ among the three groups. Similarly, Thomee *et al.* reported no difference in congruence angle between the most and the least symptomatic knees in participants with PFPS (41). Our data is consistent with the previous findings in patients with PFPS. The findings indicated that congruence angle may not be a sensitive measure of patellar displacement in patients with PFPS (26, 35). Conversely, Aglietti *et al.* reported that the mean congruence angle was greater in participants with PFP than in control group.

They used the Merchant view technique (45° knee flex) (42). The use of various radiographic techniques for measurement of this angle may account for the discrepancy between the mean angles obtained in the present study and those of the previous studies.

Findings of the current study indicated that *patella heights* (patella alta) of the two groups with PFPS were significantly greater than that of the control group. Our results are consistent with the previous findings reported by Aglietti, kannus, and Pal (36, 42, 43). Pal *et al.* reported significant difference in the rate of patella alta between participants with PFPS and healthy participants. Duration of PFPS in Pals' study was 3 months to 11 years (36). Martin *et al.* reported that there was no difference in the patella height between the PFPS group with at least 3 months duration and pain free group (32). A possible explanation for this disagreement between the findings could be the difference in the duration of PFPS. Laprad *et al.* demonstrated that there is no difference in patellar height between PFPS and pain free group using the Caton- Deschamps index (26). The disagreement between our findings with those of Laprad could be due to the method and index of measurement of patella height used. Patella alta can result in alternation of the contact area of PF joint, which results in the increase in contact stress and cartilaginous breakdown.

The results of the current study demonstrated that there is a positive correlation between patella alta and PFPS duration, meaning that patella alta is a main problem of PFPS treatment.

It is also demonstrated in the present study that lateral patellar tilt angle in patients with PFPS with a duration of 12-15 months was significantly greater than that of control group. There was no significant difference between the group with PFPS of 2-3 months duration and control group regarding this variable. These results suggest that increase in the duration of PFPS can increase lateral patellar tilt angle. We observed a positive correlation between lateral patellar tilt angle and PFPS duration, as well. This finding is similar to those reported in the previous studies. Witonki *et al.* reported that lateral patellar tilt angle significantly differ between anterior knee pain patients and asymptomatic individuals (44). Also, Pal *et al.* reported greater lateral patellar tilt angle in PFPS group with 3 months to 11 years duration than in control group (36). Martin *et al.* found that there is no difference between patients with PFP duration of at least 3 months and asymptomatic individuals (32). The difference between the results of these studies and our findings may be explained by the fact that they did not consider duration of PFPS. Also, implementing various imaging techniques and measurement methods of lateral patellar tilt angle in different studies could have resulted in contradictory results.

Lin *et al.* demonstrated that VMO in patients with PFPS produced less torque to counteract the laterally directed forces

applied to the patella by the lateral structures of the knee. Therefore, most patella were laterally tilted in patients with PFP (35). Authors have reported that quadriceps muscles, especially VMO, were weak in PFP and weakness of VMO increased by the increase in the duration of PFP, and increase in the lateral patellar tilt angle is one of its consequences (10). Hunter *et al.*, too, reported that lateral patellar tilt angle correlated with PFPS progression and pain increase. Greater lateral patellar tilt angle can result in excessive stress between lateral patellar facet and lateral trochlea and it can increase signs of PFP (19, 45).

The findings of present study showed that increase in the duration of PFPS was associated with increased functional impairment.

The current study had some limitations which must be considered before generalizing the findings. The participants represented a "Convenience" sample that were consecutively included, and thus were not randomly selected. The examiner was not blind to the allocated participants and a single examiner performed all the PF alignment measuring for the participants. Also, finding participants with 2-3 months duration proved to be difficult. Therefore, we proposed conduction of blinded studies with single-sex participants to compare the duration effects on patellar alignment in PFPS patients.

Conclusion

The present study demonstrated that increase in the duration of PFPS could increase lateral patellar tilt angle, patella alta, and pain and functional impairment. Therefore, early treatment and improvement of the patellar alignment in patients with PFPS are recommended.

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Conflict of interest:

None

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Authors' contributions:

All authors made substantial contributions to conception, design, acquisition, analysis and interpretation of data.

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